

# Understanding the Importance of Soil

**M**OST of us do not spend much time thinking about soil. You probably do not think about the soil beneath athletic fields, under the foundation of your home, or in forested areas. Nonetheless, soil provides us with a surface on which to walk and an area in which to plant. This unit will explore the importance of soil as a natural resource.



## Objective:



Explain the importance of soil.

## Key Terms:



adobe  
cropland  
geotextile  
load-bearing capacity  
shear  
shrink-swell capacity

## Soil

The earth consists of solid materials and the atmosphere surrounding them. The solid parts of the earth include the core, mantle, and crust. Most of the crust is covered with sea. The continents are landforms made of rock that is approximately 50 miles thick, and the atmosphere that envelops the earth is about 170 miles deep.

Soil is a thin layer between the crust and the atmosphere. It is one of the earth's most fragile resources, and it is an extremely important layer of life-supporting material. Most life depends on it in one way or another.

## HOW SOIL SUPPORTS LIFE

The atmosphere, crust, and soil interact to provide plants and animals with the necessary resources. Living things need the proper temperature as well as adequate amounts of oxygen, water, carbon, and nutrients to survive.

Plant roots require oxygen for growth. Because plants grow best in certain temperature ranges, the soil temperature and—to some degree—the air above the soil is controlled by a heat-exchange mechanism.

Water seldom stays in one place long because it is moving to another water cycle stage. For example, water evaporates from the land, lakes, and ocean and forms clouds in the atmosphere. Then rain falls from the clouds, moistens the soil, and fills streams and lakes. Evaporation starts the cycle again. Nutrients are exchanged in the soil; the nutrient elements cycle through the environment and are constantly recycled, rather than lost.

### Nutrient Cycles

Carbon is the element most essential to all life. Plants use the sun's energy for photosynthesis. This process allows the plants to convert atmospheric carbon (carbon dioxide) to biological carbon (simple sugars). In photosynthesis, the green pigment in plant leaves (chlorophyll) cap-

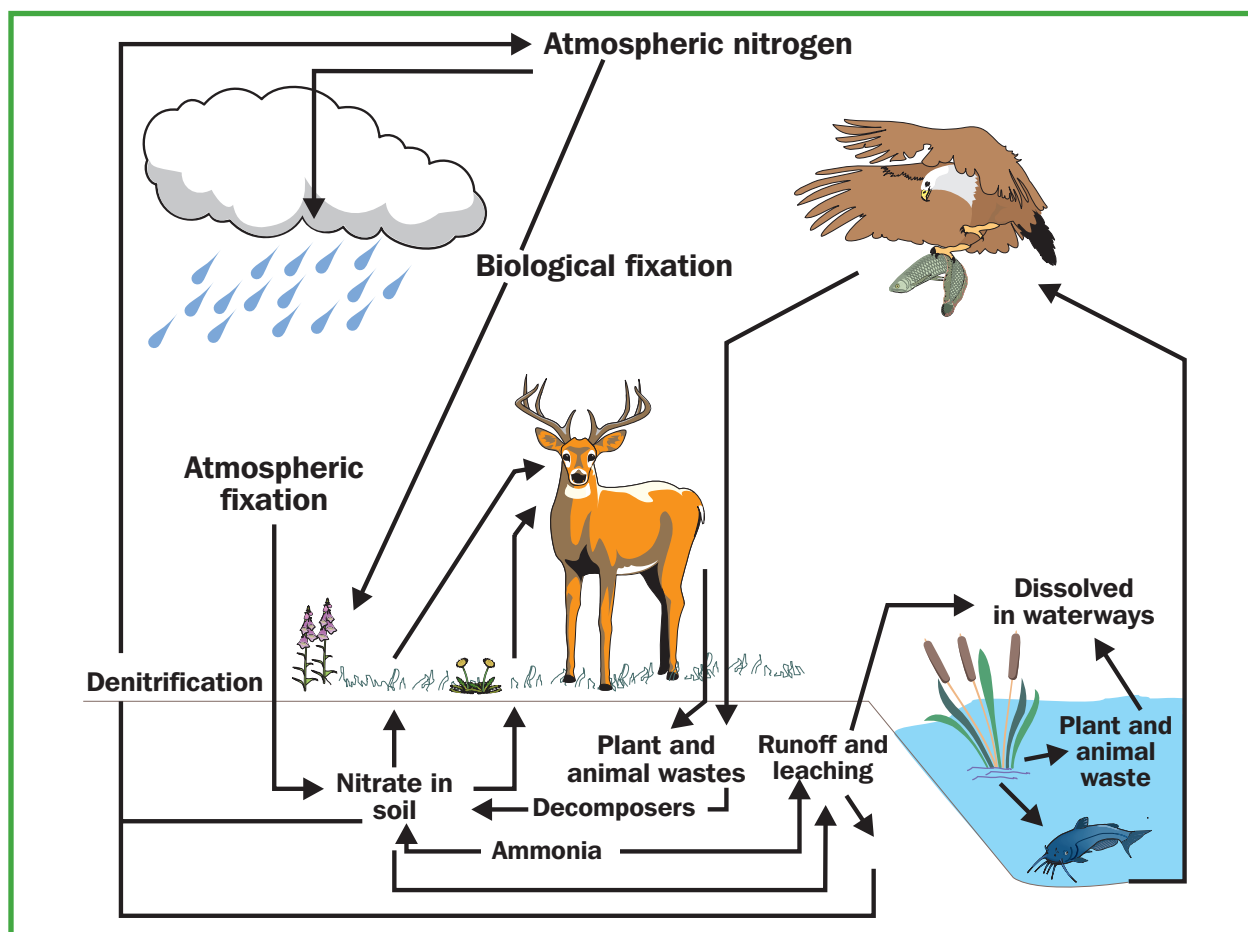


FIGURE 1. Diagram of the nitrogen cycle.

tures sunlight and uses it to fuel a series of reactions that combine the carbon from carbon dioxide with the hydrogen from water to produce simple sugars.

Some of the carbon is recycled directly back to the atmosphere by plant and animal respiration. Cellular respiration is the opposite reaction to photosynthesis. In cellular respiration, sugars are broken down to release energy. In the process, oxygen combines carbon and hydrogen to produce carbon dioxide and water. Other carbon is recycled by the decomposition of organic matter.

The nitrogen cycle is one of the most important nutrient cycles for life on earth. Nitrogen comes entirely from the atmosphere, where it occurs as a gas that plants cannot use. Soil organisms change gaseous nitrogen into forms that plants can use. Some of the nitrogen is recycled as living creatures die and return nitrogen to the soil; some nitrogen is carried deep into the ground by water; and some of the nitrogen returns to the air when microbes change it back into its original form.

Other nutrients, such as phosphorus and potassium, originate from rocks in the earth's crust. These nutrient elements are released when rock is broken down by weather, plants, and other factors. In the interchanges between the crust, soil, and atmosphere, soil temporarily stores the nutrients for plant use.

## SOIL AS A MEDIUM

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Plants depend on soil to supply four needs: anchorage, water, oxygen, and nutrients for roots.

### **Anchorage**

Plants are firmly supported or anchored by roots that grow in the soil. Firm support allows plants to grow upright.

### **Water**

Roots are a plant's best water-absorbing body. Soil supplies nearly all of the water that a plant uses. For each pound of dry matter produced by growth, different plants obtain between 200 and 1,000 pounds of water from the soil for photosynthesis, sap flow, and other uses. The water-holding capacity of a soil is important for agricultural purposes.

### **Oxygen**

All living creatures—with the exception of a few microscopic organisms—need oxygen. Plants release oxygen during photosynthesis, but they consume it during respiration. The parts of the plant above ground are surrounded by an atmosphere that is 21 percent oxygen, so these parts have all the oxygen they need. Plant roots and organisms that live in the soil take in oxygen from the soil and emit carbon dioxide. As a result, soil air has less oxygen and more carbon dioxide than the atmosphere, making soil aeration (the constant exchange between soil and atmospheric air) important.

## Nutrients

Soil has an important function in recycling nutrients needed for plant growth. Of the 16 nutrients considered essential for normal plant growth, 13 are obtained from the soil. Carbon, oxygen, and hydrogen are obtained from the air and water. The rest are stored in the soil.

Plant leaves are able to absorb some of the nutrients, but most nutrients are absorbed through the roots. Root hairs absorb plant nutrients dissolved in the soil solution by an active process that moves nutrients into root cells.

## AGRICULTURAL USES OF SOIL

People use soil to grow food, fiber, timber, and ornamental plants. However, the primary agricultural use of soil is to grow plants.

### Cropland

Different agricultural uses require different soil management practices. **Cropland** is land on which soil is worked and crops are planted, cared for, and harvested. Annual crops account for the greatest acreage of cropland planted and harvested within one growing season. Annual crops allow for yearly soil preparation to control weeds and to work fertilizer and organic matter into the soil. However, if the soil surface is bare or moderately bare, erosion is a concern.

Perennial forages are grown for a few years before replanting. Some may be harvested for hay or used for grazing. Despite the use, they cover the soil completely and keep it from washing away. Because the soil is not tilled each year, fertilization practices are different and the soils tend to improve over time.



FIGURE 2. This cropland is being worked prior to planting.

### Grazing

Much of the land in the United States is used to graze animals. In the eastern half of the country, pasture is planted to perennial forages. In the western half of the country, most grazing is on rangeland that consists of native grasses and shrubs; these are popular forages because of the drier climate.

## Forests

Forests and forest management are dependent upon soils. Forests disturb the soil the least, but soil management is still a major concern. For instance, the harvesting of trees requires special considerations. If the trees are harvested after many years of growth, the logging equipment may destroy the vegetative cover, compact the soil, and lead to severe erosion. Other considerations for forestry include choosing the best trees for each soil type and ensuring good conditions for new plant seedlings.

## NON-AGRICULTURAL USES OF SOIL

Many human activities require soil. Non-agricultural uses of soil include recreation, engineering projects, and waste disposal.

### Recreation

Recreational uses of the soil surface are important. Playgrounds, ball fields, jogging paths, golf courses, parks, and campgrounds are areas used for recreation. The design of such recreational areas is a specialized skill that requires the knowledge of soil properties. Sports playing fields require the most demanding of all soil uses. Growing turf against the punishment of the human foot can challenge the best of managers. Rather than native soil, the best playing fields consist of mixes of loam, specific sizes of sand, and more.



FIGURE 3. Camping is one way in which soil is used for recreation.

Athletic fields generally have several soil layers that are carefully graded, drained, and maintained. Soil managers who deal with playing fields are concerned with the sideways pressure from shoes tearing the soil surface; this action is called **shear**.

Playing fields are designed to have good shear resistance and hardness. **Geotextile**, a plastic mesh, may be used to hold the soils in place. After all, it is essential for the soil to provide a proper playing surface that helps to reduce injuries. The soil must dry quickly after a rain, but it needs to hold enough water to grow good turf.

### Engineering

Before the construction of a building, highway, railroad, or bridge, the soil is tested. The structural soundness of the project depends on the skills of the builders and on the soil that supports the project. For example, foundations may crack if the soil settles under the structure.

Important engineering properties of **shrink-swell capacity** and **load-bearing capacity** must be considered prior to construction. Many soils swell when wet and shrink as they dry; the higher the shrink-swell capacity, the more likely it is to observe cracking walls, destroyed foundations, and broken buried pipes. Soils high in clay or organic matter have low load-bearing capacity, and structures built on such soils are likely to shift and crack.

Before long-distance shipping of building materials became practical, people generally built their homes from locally available materials. **Adobe**, a sun-baked mixture of three parts sandy soil to one part clay soil, has been used as a building material for thousands of years.

Soil is used in the construction of energy-efficient housing. Buildings can be built underground, into hillsides, or with soil piled over them. Earth-sheltered buildings are warm in the winter and cool in the summer, reducing the heating and cooling costs.

## Waste Disposal

Soil has long been used for waste disposal. Society generates large amounts of waste, and handling waste in a safe manner is difficult and sometimes hazardous. Treatment of human sanitary waste often relies on soil because it removes some of the hazardous material, while microorganisms break down organic portions into less dangerous compounds.



FIGURE 4. Sludge is being spread on this soil to increase fertility.

Sewage treatment plants produce sewage sludge that can be spread on soil. Sewage sludge can be useful as a source of nutrients and/or organic matter as long as possibly harmful materials in the sludge are carefully considered.

Sanitary landfills require soils that will not allow hazardous materials to leach into the water table or to enter neighboring streams or lakes. The use of soils for these purposes is especially important with hazardous chemical or radioactive waste.

## Summary:



Soil makes up a thin layer between the crust and the atmosphere. The atmosphere, crust, and soil interact to provide plants and animals with the proper temperature in addition to adequate amounts of oxygen, water, carbon, and other nutrients.

Plants depend on soil to supply four needs: anchorage, water, oxygen, and nutrients for roots. Plants are firmly supported or anchored by roots that grow in soil. The soil supplies nearly all the water a plant uses. Plant roots and organisms that live underground take in oxygen from the soil. In fact, 13 of the 16 essential nutrients are obtained from the soil.

People depend on soil to grow food, fiber, timber, and ornamental plants. The primary agricultural use of soil is plant growth. Soil supports crops, plants for grazing, and forests. Non-agricultural uses of soil include recreation, engineering projects, and waste disposal.

### Checking Your Knowledge:

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1. How is soil related to the earth's crust and atmosphere?
2. What does soil provide to plants and animals?
3. What are four plant needs that are provided by soil?
4. How is soil used for agricultural purposes?
5. How is soil used for non-agricultural purposes?

### Expanding Your Knowledge:

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Create a list of how soil supports human activities and life on earth. Consider the role soil plays in providing humans with their needs and luxury items.

### Web Links:

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#### The Importance of Soil

<http://www.soilassociation.org/web/sa/saweb.nsf/ed0930aa86103d8380256aa70054918d/0f1a4812774b8c2380257149004cb42a!OpenDocument>

#### Soil Use

<http://soils.usda.gov/use/>